Fruit and Vegetables in the American Diet: Data from the NHANES II Survey

BLOSSOM H. PATTERSON, MA, GLADYS BLOCK, PHD, WILLIAM F. ROSENBERGER, MPHIL, DAVID PEE, MPHIL, AND LISA L. KAHLE, BA

Abstract: Twenty-four hour dietary recall data from the Second National Health and Nutrition Examination Survey (1976–80) were used to estimate the numbers of servings of fruit and vegetables consumed by Black and White adults, to examine the types of servings (e.g., potatoes, garden vegetables, fruit, and juice), and to estimate the mean intake of calories, fat, dietary fiber, and vitamins A and C by number of servings. An estimated 45 percent of the population had no servings of fruit or juice and 22 percent had no servings of a vegetable on the recall day. Only 27 percent consumed the three or more servings of vegetables and 29 percent had the two or more servings of fruit recommended by the US Departments of Agriculture and of Health and Human Services; 9 percent had both. Consumption was lower among Blacks than Whites. The choice of vegetables lacked variety. Diets including at least three servings of vegetables and two servings of fruit contained about 17 grams of dietary fiber. Although caloric and fat intake increased with increasing servings of fruit and vegetables, the percent of calories from fat remained relatively constant. Although these data are 10 years old, more recent surveys have shown similar results. The discrepancy between dietary guidelines and the actual diet suggests a need for extensive public education. (*Am J Public Health* 1990; 80:1443–1449)

Introduction

In a recent article,[1] it was found that a large proportion of the adult United States population eats no vegetables (0.17) or fruit (0.41) on any given day. The Surgeon General's Report on Nutrition and Health[2] recommends increasing consumption of vegetables and fruit. Based on a comprehensive literature review, the National Academy of Sciences (NAS) concluded that diet influences the risk of several major chronic diseases and recommended eating five or more daily servings of a combination of vegetables and fruit, especially green and yellow vegetables and citrus fruit.[3] The US Department of Agriculture (USDA) and the Department of Health and Human Services (DHHS) recommend as part of their food guidance system that the daily diet include two to three servings of fruit and three to five servings of vegetables.[4,5] These specific recommendations are in the context of general recommendations for a diet that meets nutrient requirements, does not include excessive amounts of fat (in particular saturated fats), and is consistent with maintaining desirable weight. It is important therefore to determine what relation increased fruit and vegetable consumption might have, not only to intake of obviously related nutrients such as vitamins A and C but also to fat intake and maintenance of appropriate body weight. In the NHANES II data, collected between 1976 and 1980, it is possible to examine these relationships in self-selected diets that were actually consumed during a 24-hour period by a representative sample of US adults.

The article mentioned above[1] described the proportions of the US population that consumed any amount of a given food, however large or small; no attempt was made to determine the number of servings consumed. In the present inquiry we estimate the number of servings consumed, taking portion size into account. We also examine the intake of calories, fat, fiber, and vitamins A and C in the diets of persons consuming various numbers of servings of fruit and vegetables. While it is obvious that intake of vitamins A and C would increase with increasing numbers of servings, the relative contribution of fruit versus vegetables is not well known, nor is the nutrient intake actually achieved in self-selected diets. Similarly, the dietary fiber intake contained in diets including multiple servings of fruit and vegetables may be inadequately appreciated by the general public.

Methods

The NHANES II survey was conducted by the National Center for Health Statistics between 1976 and 1980.[6] A highly stratified multi-stage probability design was used to obtain a representative sample of the civilian noninstitutionalized population, ages six months to 74 years; we report on 10,313 White and 1,335 Black adults ages 19 to 74. We excluded other races because of small numbers, as well as imputed, unreliable, or surrogate data. Results are based on weighted data, permitting inference about the total Black and White noninstitutionalized US population.[7] Group means and standard errors were calculated using software appropriate for complex sample survey data.[8] Standard errors are frequently large for Blacks, due to their small number in the survey. Therefore, results for Blacks should be viewed with caution. Conversely, standard errors for Whites are small due to the very large sample size, so that small differences in intake, while not biologically meaningful, could be statistically significant.

Dietary interviews were conducted by interviewers with a knowledge of food preparation and nutrient composition. A measure of portion size was obtained using three-dimensional food models, as well as dishes and glassware of various sizes. Subjects were asked to report all food and drink consumed in the 24-hour period before the interview day. Almost all recall days were weekdays. Food codes, food weight, and nutrient values were based on data from the USDA, industry, and other sources.[9] The coding of these foods has been described elsewhere.[10] Based on reported portion sizes, the number of grams consumed was calculated and included on the 24-hour recall tape[11] for each food reported by each respondent.

Address reprint requests to Blossom H. Patterson, MA, Clinical and Diagnostic Trials Section, Biometry Branch, Division of Cancer Prevention and Control, National Cancer Institute, Executive Plaza North, Rm 344, Bethesda, MD 20892. Dr. Block is also with that Section at NCI; the other co-authors are with Information Management Services, Inc., Silver Spring, MD. This paper, submitted to the Journal August 3, 1989, was revised and accepted for publication May 10, 1990.

© 1990 American Journal of Public Health 0090-0036/90$1.50

We converted the number of grams reported for each fruit and vegetable into a number of servings as follows. We used as a guide suggested serving sizes given by a food guidance system developed to help implement the USDA/DHHS dietary guidelines.[5] For fruits, a serving is defined as an average piece of whole fruit or six ounces of fruit juice, and for vegetables, one-half cup, cooked or raw. An examination of a sample of actual food records showed that some reported amounts of fruit or vegetables, such as a slice of onion on a hamburger, or lemon juice added to tea, were too small to be considered a serving, while others were so large that they should be considered as more than a single serving. We chose a lower limit of one ounce (30 grams) for any serving of a fruit or vegetable, and two ounces (62 grams) for fruit juice. Small lower limits on a single serving were chosen so as not to eliminate portions consumed by persons with small appetites. This choice may result in some overestimation of the proportions eating one or more servings on the recall day. We chose an upper limit for a single serving so that a large portion (eaten on a single occasion) would be treated as more than a single serving. A single portion of a fruit or vegetable was considered to be at most two servings so as not to overestimate the number of servings of big eaters. Juice consumed on a single eating occasion was considered (at most) three servings.

In order to convert a large portion of whole fruit or vegetables into two servings, we determined a representative or "typical" number of grams in a half cup serving of vegetables, and the weight of an "average" piece of fruit, using weights given for the most popular[1] vegetables and fruits in Agriculture Handbook No. 456.[12] A half cup serving of many vegetables weights about 75 grams, and many whole fruits weigh roughly 120 grams. We defined as two servings any portion of vegetables (except salad) weighing 150 grams or more, and any portion of fruit (excluding fruit juice) weighing 240 grams or more. For fruit juice, individuals consuming between 12 and 18 ounces (372 to 557 grams) were given credit for two servings of fruit, and those consuming 18 or more ounces (558 or more grams) were given credit for three servings. An individual eating a green salad on a single occasion was given credit for a single serving rather than for multiple servings corresponding to each ingredient. Thus individuals could be credited with a maximum of one salad per eating occasion, or a maximum of the four different occasions per day coded in the survey.

Individual foods included in each food category are given elsewhere.[1] Vegetables include potatoes, dried peas and beans (e.g., black-eyed peas, kidney beans), green salad (primarily lettuce and raw tomatoes), as well as all other vegetables not falling into one of these categories. This last group is designated "garden vegetables" and includes, for example, green beans, corn, and broccoli. "Fruit" refers to whole fruit and fruit juice. In this article, fruit juices include citrus and other natural fruit juices, but exclude both fortified and non-fortified fruit "drinks." A list is available from the authors on request.

We report mean nutrient intake by number of servings (0, 1, 2, 3 or more) of fruit cross-classified by number of servings of vegetables. Nutrient intake was calculated by the National Center for Health Statistics, using USDA nutrient data, updated 1980. Because consumption of fruit and vegetables is associated with age, sex, and race,[1] we controlled for these factors in each cell of the cross-classification tables using a method equivalent to direct standardization. This method for finding means and the corresponding variance estimates, adjusted for age, race, and sex, is given in the Appendix. The method uses regression coefficients to obtain estimates of means.

Results

Because the NHANES II data were collected before the recommendations above were issued, they do not reflect their impact; rather the guidelines are used as a standard against which to describe the diet. In the spirit of both the USDA/DHHS and NAS guidelines, we define three or more servings of vegetables and two or more servings of fruit as meeting the vegetable and fruit guidelines, respectively. The proportions meeting these guidelines are shockingly small (Table 1). On the recall day, 27 percent met the vegetable guidelines and 29 percent met the fruit guidelines, while only 9 percent met both. In general, proportions were highest among older Whites but, even in this group, fewer than one-third ate the recommended servings of vegetables, and fewer than half ate the recommended servings of fruit. More men had adequate numbers of servings of vegetables than did women; the opposite was true for fruit. About two-thirds as many Blacks as Whites met these guidelines. Only about 5 percent of Black women and 7 percent of Black men consumed the recommended numbers of both fruit and vegetable servings.

Eleven percent ate neither fruit nor vegetables on the recall day, 45 percent had no servings of fruit, and 22 percent had no servings of a vegetable (Table 2). In contrast to the five or more servings of fruit and vegetables recommended, zero or one serving might be considered clearly inadequate. Thirty-five percent of Black adults and 27 percent of White adults had at most one serving of a food in the fruit/vegetable food group (data available from author on request).

Mean numbers of servings of fruit (1.08, SE = .03) and vegetables (1.77, SE = .02) were far below recommended levels and were lower for Blacks than for Whites (data available from author on request). Mean vegetable intake was

TABLE 1—Proportions (standard error) of Persons Ages 19–74 Who Met or Exceeded the USDA Guidelines, by Race, Sex, and Age Group: Estimates Based on Data from NHANES II, 1976–80.

	Age Group (years)			
	19–29	30–54	55–74	All Ages
Fruit and Vegetables† Guidelines (2+ Fruits and 3+ Vegetables)*				
White Males	.08 (.01)	.09 (.01)	.12 (.01)	.09 (.01)
Black Males	.05 (.01)	.08 (.02)	.08 (.02)	.07 (.01)
White Females	.05 (.01)	.08 (.01)	.15 (.01)	.09 (<.01)
Black Females	.04 (.02)	.03 (.01)	.08 (.02)	.05 (.01)
All	.06 (.01)	.08 (.01)	.13 (.01)	.09 (<.01)
Vegetable Guidelines (3 or more servings)				
White Males	.32 (.01)	.31 (.01)	.31 (.01)	.31 (.01)
Black Males	.22 (.04)	.20 (.04)	.23 (.05)	.21 (.02)
White Females	.21 (.01)	.25 (.01)	.28 (.01)	.25 (.01)
Black Females	.15 (.03)	.18 (.04)	.20 (.03)	.18 (.02)
All	.25 (.01)	.27 (.01)	.28 (.01)	.27 (.01)
Fruit Guidelines (2 or more servings)				
White Males	.21 (.02)	.25 (.01)	.35 (.01)	.26 (.01)
Black Males	.16 (.03)	.24 (.03)	.22 (.03)	.21 (.02)
White Females	.24 (.02)	.28 (.01)	.47 (.02)	.32 (.01)
Black Females	.24 (.05)	.20 (.03)	.32 (.05)	.24 (.02)
All	.22 (.01)	.26 (<.01)	.40 (.01)	.29 (<.01)

*Whole fruit and fruit juice

† Potatoes, salad, dried peas and beans, all other vegetables (denoted "garden": see text)

TABLE 2—Proportions (standard error) of Persons Ages 19–74 and Numbers in Sample, by Numbers of Servings of Fruit and/or Vegetables Consumed: Estimates Based on Data from NHANES II, 1976–80

Servings of Fruit*	Servings of Vegetables†				
	0	1	2	3+	All
0	.11 (<.01) 1,306	.11 (<.01) 1,244	.11 (<.01) 1,233	.11 (<.01) 1,247	.45 (.01) 5,030
1	.05 (<.01) 633	.07 (<.01) 814	.07 (<.01) 804	.07 (<.01) 847	.26 (<.01) 3,098
2	.03 (<.01) 325	.04 (<.01) 450	.04 (<.01) 486	.05 (<.01) 562	.15 (<.01) 1,823
3+	.02 (<.01) 261	.03 (<.01) 403	.04 (<.01) 481	.04 (<.01) 552	.14 (.01) 1,697
All	.22 (.01) 2,525	.26 (.01) 2,911	.26 (.01) 3,004	.27 (.01) 3,208	1.000 11,648

*Whole fruit and fruit juice
† Potatoes, salad, dried peas and beans, all other vegetables (denoted "garden": see text)

somewhat higher for males than females; the opposite was true for fruit and juice. The mean number of servings of garden vegetables, a group including the green and yellow vegetables emphasized by the NAS guidelines, was only 0.65 (SE = .01).

At least one serving of garden vegetables was eaten by 43 percent of the adult population, and there were no notable differences by race or sex (Table 3). Potatoes and salad were more popular among Whites than Blacks. Proportions eating fried potatoes declined with age, while those consuming non-fried potatoes increased (data available on request to author). Dried peas and beans, good sources of fiber, were eaten by only about 10 percent of the population.

About half the population consumed no servings or only one serving of a vegetable (Figure 1). Among those who reported only one serving of a vegetable, salad was the most popular, reported by 39 percent. Twenty-nine percent consumed a serving of potatoes as their only vegetable, and over half of these servings of potatoes were fried. Among those reporting two servings of a vegetable, some did not achieve variety: 9 percent had two servings of potatoes, 7 percent reported two servings of salad, and 5 percent ate two servings of dried peas and beans.

Only slightly more than half of the population (55 percent) had at least one serving of fruit or fruit juice. Of these, 27 percent had juice only, and 45 percent had whole fruit only (data available on request to author).

Table 4 shows average intake of dietary fiber, vitamin A, and vitamin C among persons consuming various numbers of servings of fruit and vegetables. These nutrient levels represent dietary intake from all food sources, but exclude vitamin supplements. Persons who consumed neither fruit nor vegetables had, on average, only 5.6 grams of fiber in their diet on the recall day, or about one-fourth of the 20–30 grams recommended by the National Cancer Institute.[13] The amount of fiber in these self-selected diets increased with the total number of servings of fruit and vegetables consumed, and this increase was similar for both fruit and vegetables. A total of five servings of a combination of fruit and vegetables was associated with an intake of approximately 17 grams of fiber. The recommended level of fiber intake was achieved only by those who had three or more servings of *both* fruit and vegetables, a group representing only 4 percent of the US adult population.

In the United States, it is estimated that the usual foods available to consumers provide about half of the total vitamin A activity in the diet as provitamin A carotenoids, found in plant products, and the other half as retinol.[14] Among those eating both fruit and vegetables, the US Recommended Daily Allowance (RDA) of 5000 IUs of vitamin A was attained only by those having at least two servings, while five servings of a combination of fruit and vegetables were associated with mean vitamin A intake of about 8000 IUs. If either vegetables or fruit were eaten to the exclusion of the other (true of over half the population), the US RDA was reached only among those having three or more servings.

For vitamin C, fruit and vegetables represent the primary source in the US diet,[10] and Table 4 shows that fruit in particular is associated with higher intake. Among those consuming no fruit, the US RDA of 60mg was attained only by those who had three or more servings of vegetables. This is notable in view of the fact that 45 percent of the US population consumed no servings of fruit on the day of the survey.

Table 5 shows caloric and fat intake by servings of fruit and vegetables. Caloric intake increased as numbers of servings of either food increased. However, the additional calories were not due to the fruit or vegetables alone, as fat intake also increased substantially. This is presumably due in part to fats such as butter and margarine added to potatoes and other vegetables and to oils in salad dressings; people who eat more servings of fruit and vegetables may also eat more food in general. The increase in dietary fat intake associated with increased servings of vegetables was greater than that associated with increased servings of fruit (data available on request to author). Those who ate no fruit and three or more servings of vegetables had an average of 95 grams of fat in their diets, while those who ate three servings of fruit and no vegetables had 78 grams.

TABLE 3—Proportions (standard error) of Persons Consuming One or More Servings of a Vegetable, by Race, Sex, and Type of Vegetable: Estimates Based on Data from NHANES II, 1976–80

Type of Vegetable	Whites		Blacks		All
	Males	Females	Males	Females	
Garden Vegetables*	.42 (.01)	.44 (.01)	.41 (.03)	.44 (.02)	.43 (.01)
Potatoes					
Fried	.22 (.01)	.13 (.01)	.15 (.02)	.10 (.01)	.17 (<.01)
Not Fried	.28 (.01)	.26 (.01)	.20 (.02)	.20 (.02)	.26 (.01)
All	.46 (.01)	.37 (.01)	.33 (.03)	.30 (.03)	.40 (.01)
Salad	.39 (.01)	.40 (.01)	.19 (.02)	.24 (.02)	.37 (.01)
Dried Peas and Beans	.11 (.01)	.08 (.01)	.13 (.02)	.10 (.02)	.10 (.01)

*All vegetables except potatoes, salad, and dried peas and beans. Examples are green beans, carrots, and corn.

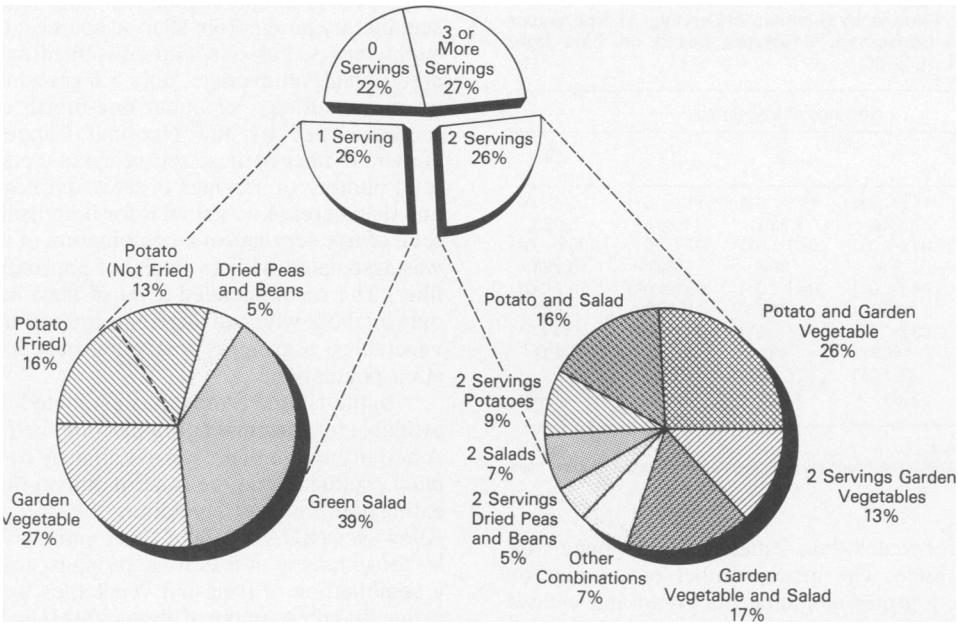

FIGURE 1—The top pie chart shows the percentages of individuals who consumed zero, one, two, or three or more servings of vegetables on the recall day. Percentages are estimates based on data from NHANES II, 1976–80. The lower left pie chart displays the type of vegetable consumed by those who consumed only one serving of a vegetable. The pie chart on the lower right displays the types of vegetables consumed by those who had exactly two servings of a vegetable. The category "garden vegetables" includes all vegetables except potatoes, salad, dried peas and beans. Examples are green beans, carrots, and corn.

When we express fat as a percent of calories, there was a small increase with increasing vegetable intake, approximately two percentage points from the lowest to the highest serving category. In contrast, with increasing fruit consumption, the percent of calories from fat fell approximately five percentage points from the lowest to the highest consumption category. Percent of calories from saturated fat behaved similarly, reaching its highest value among those who consumed no fruit and two or more vegetables, and its lowest value among those who consumed three or more servings of fruit and no vegetables (data available from authors on request).

Although the percent of calories from fat increased slightly with increasing vegetable consumption, this was associated with an increase in the ratio of polyunsaturated fats to saturated fats (P/S ratio), the direction recommended by the American Heart Association[15] (data available from authors on request). This may reflect the use of unsaturated oil in salad dressings.

Despite the increase in caloric intake and dietary fat with increasing numbers of servings of fruit and vegetables, there was no associated increase in obesity (data available from authors on request). A commonly used measure of obesity, the Quetelet Index (weight(kg)/height(m)^2) was relatively constant across all serving categories, ranging from 24.9 (SE = .27) to 25.6 (SE = .18). This may reflect differences in energy expenditure associated with higher caloric levels.

Discussion

"In this land of plenty millions of Americans aren't eating wisely. Not because they haven't enough to eat, but because they eat too many of the wrong things or too little of the right,"[17] according to the USDA. Based on 24-hour recall data, we found that 91 percent of the adult US population did not meet the USDA/DHHS recommendation that two to

TABLE 4—Mean Intake of Various Nutrients (Standard Errors) by Number of Servings of Fruit and Vegetables, Adjusted for Age, Race, and Sex: Estimates based on Data from NHANES II, 1976–80

	Servings of Vegetables†			
	0	1	2	3 or more
*Servings of Fruit**	Dietary Fiber (g)			
0	5.6	6.62	9.7	13.8
	(.2)	(.2)	(.3)	(.5)
1	7.7	8.8	10.5	14.8
	(.2)	(.3)	(.3)	(.4)
2	9.9	11.0	13.2	16.6
	(.3)	(.3)	(.3)	(.3)
3 or more	13.8	14.7	17.2	21.0
	(.5)	(.3)	(.4)	(.5)
	Vitamin A (IU)			
0	2998	3333	4880	5882
	(167)	(189)	(430)	(269)
1	3804	5364	5311	6789
	(314)	(649)	(279)	(325)
2	3876	5372	5855	7934
	(253)	(451)	(283)	(456)
3 or more	5330	7041	8924	10393
	(393)	(403)	(615)	(526)
	Vitamin C (mg)			
0	25.9	38.3	51.4	79.6
	(2.1)	(1.7)	(1.8)	(3.4)
1	73.0	95.5	102.7	130.0
	(2.0)	(4.4)	(2.7)	(3.7)
2	114.4	123.5	145.0	163.0
	(6.9)	(3.3)	(4.6)	(3.9)
3 or more	218.0	211.8	222.8	248.3
	(12.0)	(10.7)	(7.0)	(9.7)

USRDA for vitamins A and C is 5000 IU and 60 mg respectively. The National Cancer Institute recommends a daily fiber intake of 20–30g with an upper limit of 35 g.

*Whole fruit and fruit juice

†Potatoes, salad, dried peas and beans, all other vegetables (denoted "garden": see text)

TABLE 5—Mean Caloric and Fat Intake (standard errors) by Number of Servings of Fruit and/or Vegetables, Adjusted for Age, Race, and Sex (Estimates based on Data from NHANES II, 1976–80)

	Servings of Vegetables†			
	0	1	2	3 or more
*Servings of Fruit**	Calories			
0	1633 (30)	1817 (26)	1950 (33)	2230 (47)
1	1741 (34)	1890 (36)	1941 (32)	2264 (70)
2	1924 (51)	1937 (48)	2029 (43)	2249 (49)
3 or more	2112 (84)	2137 (59)	2173 (57)	2369 (50)
	Fat *(g)*			
0	64.4 (1.3)	75.6 (1.8)	84.4 (1.8)	95.4 (2.1)
1	69.1 (1.9)	79.7 (1.9)	81.2 (1.6)	98.3 (3.5)
2	75.8 (2.9)	77.2 (2.5)	81.3 (2.3)	93.5 (3.3)
3 or more	77.6 (3.7)	83.2 (3.1)	83.3 (3.0)	92.0 (2.4)
	Percent Calories from Fat‡			
0	37.6 (.3)	40.1 (.4)	40.6 (.3)	40.3 (.3)
1	36.1 (.3)	38.9 (.4)	38.6 (.3)	39.8 (.4)
2	36.1 (.5)	36.5 (.5)	36.9 (.5)	37.8 (.3)
3 or more	32.7 (.7)	35.0 (.6)	34.4 (.5)	34.8 (.4)

*Whole fruit and fruit juice
† Potatoes, salad, dried peas and beans, all other vegetables (denoted "garden": see text)
‡ Calculated as percent of nonalcohol calories.[16]

three servings of fruit and three to five servings of vegetables be eaten daily.

Our method of defining a serving in terms of the number of grams eaten at any given meal, as opposed to the total number of grams consumed during the entire 24-hour period, may have resulted in some bias in the estimation of number of servings. Small portions (weighing less than an ounce) might sum to a serving over the course of a day, resulting in an underestimation. This bias is probably minimal because of the small lower limits (one ounce of fruit or vegetable) used in the estimation. Conversely, these small limits might result in an overestimation of the number of servings; our lower limit is equivalent to less than half of a serving as defined by the USDA. The second bias is likely larger than the first and, if so, the results presented in this article are unduly optimistic.

While a single day's food record cannot be used to characterize an individual's usual diet, 24-hour recall data can provide estimates of group means.[7] Our finding that 11 percent had no servings of either fruit or vegetables on the recall day is in close agreement with data from the NHANES II food frequency questionnaire in which 12 percent reported that they eat fruit and vegetables less frequently than daily, and with 24-hour recall data from the Nationwide Food Consumption Survey (NFCS), conducted by the USDA in 1977–78, in which 10 percent of women and 8 percent of men ages 19–50 reported eating no fruit or vegetables on the recall day.[18]

A comparison of 24-hour dietary recall data among adults ages 19–50 from the NFCS and from the 1985 and 1986 Continuing Survey of Food Intakes (CSFII),[19–21] also conducted by the USDA, suggests that there has been little change in the percentages using these foods. The proportion of men reporting eating any vegetables on the recall day decreased from 89 to 85 percent between 1977 and 1985, while the proportion reporting fruit consumption was virtually unchanged: 44 percent in 1977 and 43 percent in 1985. For women, changes were also minimal: in 1977, on the recall day, 84 percent reported eating a vegetable, compared to 83 percent in 1985; 50 percent reported eating fruit in 1977 and 47 percent in 1985. CSFII data for women in 1986 were similar. A study of food consumption trends based on NFCS and CSFII data reported that proportions of women using green and yellow vegetables and "lower-fiber" vegetables such as lettuce and tomatoes increased slightly during this period, while proportions using "higher-fiber" vegetables such as corn, green peas, and cooked cabbage decreased.[22] While data from the USDA surveys are directly comparable, these surveys differ somewhat from the NHANES II survey in sampling and in data collection methods. Further, the USDA vegetable group is slightly more comprehensive than ours, and their fruit group excludes some citrus fruit juices, such as lemonade, that were included in our study. Recent promotion of dietary fiber may have produced some increase in the consumption of fruit and vegetables, but is unlikely to have resulted in changes of the magnitude needed to meet the guidelines.

Results of a small survey (298 adults selected by random digit dialing) conducted in two counties in California in 1987[23] were similar to our findings. Fifty-two percent reported that they had eaten one or more fresh fruits on the previous day*; we found that 39 percent ate whole fruit on the recall day. In the California survey, 42 percent reported eating green salad and 67 percent reported eating one or more vegetables on the recall day. In our data, 37 percent had a salad and 43 percent had at least one serving of a garden vegetable on the recall day.

Dietary guidelines have emphasized the importance of a balanced and varied diet. Diets that include either no servings or very few servings of fruit and vegetables lack both balance and variety. We found that almost 50 percent of the population had at most a single serving of a vegetable; even among those who had two servings of a vegetable on the recall day, 21 percent had two servings of the same vegetable (other than a garden vegetable). For fruit and fruit juice, about three-fourths had at most a single serving.

Studies that have assessed health benefits from vegetable consumption found them primarily for garden vegetables.[24–26] We found that less than half the population had a garden vegetable on the recall day.

As in the paper on food choices,[1] we found that consumption of fruit and vegetables (with the exception of garden vegetables) was lower among Blacks than Whites, even when income was taken into account (data available on request to authors). Not only did fewer Blacks than Whites meet the guidelines, but larger proportions had at most a single serving on the recall day.

Consumption of the recommended five servings of fruit and vegetables is consistent with a nutritionally adequate diet as well as with the health recommendations cited above. For example, diets including multiple servings of these foods provide substantial amounts of dietary fiber and vitamins A

*Data provided by S. B. Foerster, personal communication.

and C. While caloric intake increases with the numbers of servings of both fruit and vegetables, this increase is not associated with greater obesity. As more servings of vegetables are eaten, more grams of fat are consumed, but the P/S ratio also rises.

The fact that fruit and vegetables are important sources of dietary fiber may not be well understood by the general public. In our data, a diet that included five servings of fruit and vegetables provided approximately 17 grams of fiber; at this level, the addition of two slices of whole grain bread would bring the total to 20 or more grams. Nutrition education campaigns might well emphasize that consumption of the recommended five-a-day is important in achieving the dietary fiber goals, as well as in increasing micronutrient intake.

Evidence has been accumulating on the relation of fruit and vegetable consumption to health, as is reflected in the NAS recommendations to increase consumption of these foods. Numerous studies suggest that we can help prevent several types of cancer by increasing our fruit and vegetable consumption.[24-26] However, the discrepancy between the America diet and the fruit and vegetable guidelines, as shown in a one day recall, is so enormous as to call into question the societal commitment to these guidelines. The public is either unaware of the likely benefits of including these foods in the daily diet or, although aware, is unwilling or cannot afford to follow the guidelines.

Fruit and vegetable consumption has never been the object of a national campaign. A recent editorial in this Journal called for "the most vigorous, collaborative nutrition campaign ever launched"[27] to make the public aware of the connection between food intake and health outcome. Any such campaign should take into account the fruits and vegetables most frequently eaten, encouraging increased consumption of those already relatively popular, and targeting demographic groups where consumption is particularly low. In addition to public education, societal commitment might include actions to improve the affordability of many fruits and vegetables and to increase the numbers of servings obtainable through school lunches, meals on wheels, and other food programs, as well as industry actions to promote increased consumption of these foods.

ACKNOWLEDGMENT

We wish to thank Dr. Susan B. Foerster for sharing with us results of the California Two-County Survey.

REFERENCES

1. Patterson BH, Block G: Food choices and the cancer guidelines. Am J Public Health 1988; 78:282–286.
2. US Department of Health and Human Services, Public Health Service: The Surgeon General's Report on Nutrition and Health. DHHS (PHS) Pub. No. 88-50210. Washington, DC: Govt Printing Office, 1988.
3. Committee on Diet and Health, Food and Nutrition Board, Commission on Life Sciences, National Research Council: Diet and Health: Implications for Reducing Chronic Disease Risk. Washington, DC: National Academy Press, 1989.
4. US Department of Agriculture, US Department of Health and Human Services: Nutrition and Your Health: Dietary Guidelines for Americans. Home and Garden Bulletin No. 232. Washington, DC: Govt Printing Office, 1980.
5. Cronin FJ, Shaw AM, Krebs-Smith SM, Marsland PM, Light L: Developing a food guidance system to implement the dietary guidelines. J Nutr Educ 1987; 19:281–302.
6. National Center for Health Statistics: Plan and Operation of the Second National Health and Nutrition Examination Survey, 1976–1980. Vital and Health Statistics Series 1, No. 15. DHEW Pub. No. (PHS) 81-1317. Washington, DC: Govt Printing Office, 1981.
7. National Center for Health Statistics: Dietary Intake Source Data: United States, 1976–1980. Vital and Health Statistics, Series 11, No. 231. DHHS Pub. No. 83-1681. Washington, DC: Govt Printing Office, 1983.
8. Shah BV: SESUDAAN: Standard Errors Program for Computing of Standardized Rates from Sample Survey Data. Research Triangle Park, NC: Research Triangle Institute, 1981.
9. Dresser CM: From nutrient data to a data base for a health and nutrition examination survey. Organization, coding, and values—real or imputed. Proceedings of the Eighth National Data Base Conference, Minneapolis, MN, July 1983.
10. Block G, Dresser CM, Hartman AM, Carroll MD: Nutrient sources in the American diet: Quantitative data from the NHANES II survey. Am J Epidemiol 1985; 122:13–40.
11. National Center for Health Statistics: Public Use Data Tape Documentation—Total Nutrient Intake, Food Frequency, and Other Related Dietary Data Tapes. Tape number 5701. National Health and Nutrition Examination Survey, 1976–1980. US Dept of Health and Human Services, Public Health Service, Office of Health Research, Statistics, and Technology. Hyattsville, MD: NCHS, February 1982.
12. US Department of Agriculture, Agricultural Research Service: Nutritive Value of American Foods, in Common Units. Agriculture Handbook No. 456. Washington, DC: Govt Printing Office, 1975.
13. National Cancer Institute: Diet, Nutrition and Cancer Prevention: A Guide to Food Choices. US Dept of Health and Human Services, NIH Pub. No. 85-2711. Washington, DC: Govt Printing Office, 1985.
14. US Department of Agriculture, Agricultural Research Service: Dietary Levels of Households in the U.S., Spring 1965. Preliminary Report ARS 62-17. Washington, DC: Consumer and Food Economics Research Division, Agricultural Research Service, US Dept of Agriculture, 1968.
15. American Heart Association: Nutrition Committee Rationale for Diet-Heart Statement of the American Heart Association, Dallas, TX. Circulation 1982; 65:839A–854A.
16. Select Committee on Nutrition and Human Needs, US Senate: Dietary Goals for the United States. Washington, DC: Govt Printing Office, 1977.
17. US Department of Agriculture and US Department of Health, Education, and Welfare: Food is More Than Just Something to Eat. US Department of Agriculture Home and Garden Bulletin No. 216, 1976.
18. US Department of Agriculture, Science and Education Administration: Food and Nutrient Intakes of Individuals in 1 Day in the United States, Spring 1977. NFCS 1977–78 Preliminary Rpt No. 2, 1980.
19. US Department of Agriculture, Human Nutrition Information Service: Nationwide Food Consumption Survey, Continuing Survey of Food Intakes by Individuals, Men 19–50 Years, 1 Day, 1985. NFCS, CSFII Report No. 85-3. Washington DC: USDA, 1986.
20. US Department of Agriculture, Human Nutrition Information Service: Nationwide Food Consumption Survey, Continuing Survey of Food Intakes by Individuals, Women 19–50 Years and Their Children 1–5 Years, 1 Day, 1985. NFCS, CSFII Report No. 85-1. Washington DC: USDA, 1985.
21. US Department of Agriculture, Human Nutrition Information Service: Nationwide Food Consumption Survey, Continuing Survey of Food Intakes by Individuals, Women 19–50 years and their children 1–5 years, 1 Day, 1986. NFCS, CSFII Report No. 86-1. Washington, DC: USDA, 1987.
22. Popkin BM, Haines PS, Reidy KC: Food consumption trends of US women: Patterns and determinants between 1977 and 1985. Am J Clin Nutr 1989; 49:1307–1319.
23. Abrams B, Kristal A, DiSogra L, Ho EE, Foerster S, Chan BS, Parker L: How well do Californians meet dietary guidelines for cancer risk reduction? 116th Program of the Annual Meeting of the American Public Health Association 1988 (Abstract).
24. Micozzi MS: Foods, micronutrients, and reduction of cancer. *In:* Moon TE, Micozzi MS (eds): Nutrition and Cancer Prevention: Investigating the Role of Micronutrients: New York: Marcel Dekker, 1989; 213–242.
25. Peto R, Doll R, Buckley J, Sporn M: Can dietary beta-carotene materially reduce human cancer rates? Nature 1981; 290:201–208.
26. Block G: Ascorbic acid in cancer prevention: The epidemiologic evidence. Am J Clin Nutr 1990; 52: (in press).
27. Crawford P: The nutrition connection: Why doesn't the public know? (editorial) Am J Public Health 1988; 78:1147–1148.

APPENDIX

We define K indicator (dummy) variables for the K + 1 cells in our classification (K = 15 for the 4 x 4 cross-classification of numbers of servings of fruits and vegetables.) The remaining P - K variables, $X_{K+1}, \ldots, Xp$, represent indicator variables for the categories into which the adjustment variables have been divided (in our case, the three age, two race, and two sex categories generate four additional dummy variables). The continuous variable for which we are adjusting is denoted Y_k, $k = 1, \ldots, K$ (for example, Y_k might be number of calories consumed by those in the k^{th} cell). Then the adjusted mean for the k^{th} cell, $k = 1, \ldots, K$, is given by the following regression model:

$$\overline{Y}_k = b_0 + b_k + b_{K+1}\overline{X}_{K+1} + \ldots + b_P\overline{X}_P$$

and the adjusted mean for the $(K + 1)^{th}$ cell is given by

$$\overline{Y}_{K+1} = b_0 + b_{K+1}\overline{X}_{K+1} + \ldots + b_P\overline{X}_P$$

where $\overline{X}_{K+1} \ldots \overline{X}_P$ are means for the whole sample, or, in our case, simply the proportion (in the population) in each age, sex, or race category. A simple interpretation can be given to the adjusted means. The adjusted mean for the k^{th} cell is the mean that would have been generated by the data if the population in the k^{th} cell had the same distribution (with respect to the race, sex, and age categories) as the entire population.

The estimated variance of the adjusted mean can be found by using the estimated variances and covariances of the b's, obtained from the SURREGR procedure,[8] software that takes into account the complex sampling design and the sampling weights.